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TRANSLATION NO. 335

DATE: 1 July 1968

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Fort Detrick
Frederick, Maryland

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#235

BACTERIAL SAMPLERS

A Translation from

Great Medical Encyclopedia

Volume III, 2nd Edition, 1957

Moscow

USSR

BACTERIAL SAMPLERS

by S. Rechmenskiy

BACTERIAL SAMPLERS - devices for the selection of samples of air in order to detect the microorganisms in it.

Devices of two types exist, the sedimentation and the aspiration types. For catching large bacterial particles or droplets that make up the suspended matter in the air, one can use the sedimentation method, known under the name of "the Koch dish method" (1881). The large bacterial molecules, in virtue of their weight, settle from the air and sow the surface of a close grained medium in the open dishes. This method is simple and widely used, however, it is impossible to determine by it the concentration of microorganisms in the air.

The following are types of the aspiration device: the Well's air centrifuge (W. Wells, 1933) with the A. I. Shafir* modification (1945), the Bourdillon, Lidwell and Thomas slit sampler (R. Bourdillon, C. Lidwell, L. Thomas, 1941) with the A. Krotov modification (1951), the S. S. Rechmenskiy air centrifuge (1951).

The Wells-Shafir air centrifuge consists of a metal container, an electric motor and a housing (fig 1). A flow of air is drawn into the opening of the cylinder during its fast rotation. Within the cylinder there is located a glass test tube, the inner surface of which is covered with a coating of a close-grained nutritious medium. Under the action of centrifugal force the particles suspended in the air precipitate onto the surface of the nutritious medium and are fixed there.

The slit sampler of Yu. A. Krotov is a wide cylinder which is covered from above by a detachable cover, beneath which, on a rotating table, is fixed an open dish with a close-grained nutritious medium (fig 2 & 3). Inside the device is an electric motor with a high pressure centrifugal fan which provides the aspiration of the air and the rotary motion of the table with the dish. The air reaches the interior of the device through a V-shaped aperture situated in the upper cover above the dish and in conformity with the projection of its radius. Passing through the aperture with a great linear velocity, the air stream "strikes" against the surface of the nutritious medium in the rotating dish and sows it with the microflora.

The S. S. Rechmenskiy air centrifuge consists of a plastic rotating disk fastened to the fan motor shaft. Along the disk's edges, on its upper surface are fastened four metal clamps for the fixation of curved glass pipes. On the inner surface of these pipes are placed cellophane sheets impregnated with vaseline oil. As a result of the rotation of the disk, the air enters the openings of the pipes and produces an "impact" effect. The bacterial dust being contained in the stream of air adheres to the surface of the cellophane sheets in the pipes and is fixed there.

In other types of aspiration devices, a high-voltage electrostatic field (6,000-8,000 v) is used for the precipitation of the bacterial particles. M. Luckiesh, L. Holladay and A. Taylor (U.S.A. 1946) proposed the most precise model of an electroprecipitator. This device, of complex construction, has a large collecting capacity in regards to the air's microflora. The precipitation of the microbic cells in the electrostatic field of this device occurs directly on the surfaces of a close-grained nutritious medium in two dishes mounted on both electrodes.

In a third category of aspiration devices, the entrapment of the microbes takes place as a result of their adsorption or attachment (adhesion) to different dry substances: Powderlike ($MgSO_4$, sand, sugar), fibrous (filter paper, glass cotton, hydrophobic cardboard), porous (gelatin, Porelon). Various liquids, in the form of foam, bubbles, or in the form of a droplet aerosol, are used for the same purposes. Also, nitrocellulose membrane filters or glass smalls are used as entrapment materials. The P. P. D'yakonov device (fig 5) consists of a glass cylinder, the bottom of which is filled with glass smalls. The cylinder is closed with a rubber plug, through which are led two glass pipes bent at right angles; the end of one of these extends to the bottom of the cylinder, and the end of the other is located beneath the plug. The entrapment capacity of the device is increased if the lower end of the long pipe has a capillary form or a spherical form with a large quantity of small holes in the side walls (Wheeler, Retger). The device is filled with a liquid (water, broth, buffer phosphate) to the upper level of the layer of smalls. The air is drawn into the sampler through pipe 1 by a suction device which can be attached with a rubber hose (through a rheometer) to the end of the short pipe 2.

The A. E. Vershigora sampler (1956) consists of a cylindrical glass container sealed at both ends, and with two lateral outlet pipes, one of them connects with the upper portion of the cylinder, the other, with the lower. Within the cylinder, at a slight distance from each other are sealed in disks with a multitude of minute perforations. The lower portion of the cylinder is filled somewhat higher than the level of the disk with a liquid (water, broth, buffer phosphate). The air enters the device through the lower lateral pipe and while being drawn through the liquid, produces a bubbling effect and

the formation of foam above the disk. The air aspiration is produced by a suction device through the upper pipe.

The S. S. Rechmenskiy siphon bacterial sampler (1939) (fig 6) consists of a glass cylinder, on one end of which is sealed a funnel 4. The narrow part of the funnel is turned into the opening of the device. Within the device, vertical to the narrowed part of the funnel, is fixed a small capillary tube that is bent at an angle. Its upper end is sealed into the opening of the funnel and runs horizontally in its opening to the end aperture, and the lower end is submerged in a bulb shaped elongation, the reservoir (3). In the upper portion of the cylinder is an opening 2 in the form of a small funnel, in which is fastened a rubber plug with a glass spatula passing through it. The wide part of this spatula is set at the level of the outlet hole at the narrowed end of the funnel within the device. The surface of the spatula is turned toward the opening of this outlet. A liquid (buffer phosphate, broth) is poured into the reservoir 3. By the suction of the air entering through the funnel 4, a siphon effect of the liquid develops in the inlet, at the wide end of the device, i.e., a fountain of minute droplets which are formed near the end opening of the constricted part of the funnel. In their path, the droplets of this fountain encounter the surface of the spatula, and striking against it undergo a finer dispersion. The microbes in the passing stream of air are adsorbed on the surface of the droplets of the liquid being diffused in the device and are added to the liquid in the bulb shaped reservoir. The air is drawn into the sampler by a suction device attached to the end of the cylinder 1 by a rubber hose (through a rheometer). The same principle of microbe entrapment mechanism is characterized by the Moulton* sampler. The use of these devices is difficult at low air temperatures due to freezing of the liquids. P. F. Milyavskaya and

I. B. Reznik, for an investigation of the air, used nitrocellulose membranes which are placed into a metal Zeits* funnel (fig 7,1). The bacteriological investigation is made by a method of "impressions", which are received by applying the inseminated membrane filters to the surface of a fine grained nutritious medium.

The S. S. Rechmenskiy air filter (fig 8) was presented in two versions. The first consists of a glass cylinder, one end of which is constricted. Within the cylinder, nearer to its other end, is sealed a porous disk. A porous mass of Porelon or an ordinary rubber sponge butts up against the surface of the disk. The porous mass is saturated with liquid (buffer phosphate, broth). The aspiration of the air is produced by a suction device through the constricted end of the cylinder. Upon the entry of the air stream through the wide opening of the cylinder, the liquid contained in the porous substance infiltrates through the perforations of the disk; this is accompanied by a forming of foam in the cylinder space. In a case where a porous rubber mass is used, it is necessary to boil it thoroughly beforehand in a metal container, or to process it with a solution of hydrogen peroxide.

In the other model of the air filter, there is used a so-called separating glass funnel, in the opening of which is sealed a fine-pore glass disk (filter). This funnel is fastened within a glass cylinder (15 x 3 cm) by the use of a rubber plug. Against the surface of the fine-pore glass filter is placed a disk of a spongy substance which is saturated with a liquid. Upon aspiration of the air through the cylinder, a bubbling effect of the liquid develops and a close-mesh foam is formed in the funnel space.

An advantage of the aspiration samplers consists of the fact that with their help, it is possible to make a quantitative calculation of microflora

for the unit volume of air. It is possible to draw the large volumes of air through the aspiration samplers that permits a concentration in the sampler of microbes that are sown in the air in even negligible quantities. Of the physical principals inherent to the entrapment mechanisms of the samplers, an advantage is held by those which are based on the processes of adsorption, adhesion and electroprecipitation. Such mechanisms in the samplers more effectively retain the most diverse, by size and aerodynamic properties, droplet and dust phases of the bacterial and viral aerosols. The majority of the constructions of the adsorption-adhesion samplers are simple, portable and convenient for use in practical activity, particularly, under field conditions.

For quick extraction of an air sample, it is possible to utilize moving automobiles, motorboats and also airplanes. The aspiration bacterial sampler is attached to the hood of the automobile or motorboat. The device must be located where the circumfluent air stream, developed during the movement of the automobile, does not carry the dust from the turning wheels, or from the surface of the hood itself. It is rational to attach the device by a flexible rod in front of the automobile's cupola at a 1.5 m height above ground level. The device is connected by a rubber hose through a rheometer to the collecting pipe of the motor, or to the aspiration inlet of the windshield wiper. The motor connected with the bacterial sampler is engaged not only during the movement of the automobile, but also while it is standing still. It is possible in both cases to extract an air sample either consecutively at several points of a territory being investigated, or "distantly" on specific trajectories of its air space (fig 9). On an airplane, the striking force of the counter flow of air is used, this enters the bacterial sampler and activates the entrapment mechanism. Electronic devices are used for the computation of the number of

particles or droplets, and also for their assessment by sizes; the principles of their construction are varied. Particles of a bacterial aerosol are computed by the F. Gukker* photoelectric meter, or by the measurement of an electrostatic charge which is transmitted by every particle in the form of an electrical impulse to a metallic filament which is located in the flow path of the particles through a narrow jet. The A. Gayton meter is built on this principle. See also: Bacterial filters, Bacteria.

ILLUSTRATIONS

Fig 1. Layout Diagram of the Aero-centrifuge by Wells and Schaeffer: 1 -- nozzle with intake orifice and manometric tube; 2 -- clamps; 3 -- casing for the ventilator rotor; 4 -- air duct; 5 -- principal part of the apparatus; 6 -- motor; 7 -- special self-regulating bushing.

Fig 2. Krotov's Slit Apparatus (general view).

Fig 3. Diagram of Krotov's Slit Apparatus: 1 -- plexi-glass disc; 2 -- blade slit; 3 -- Petri dish; 4 -- disc; 5 -- ventilator; 6 -- cylinder; 7 -- electro-motor; 8 -- impeller; 9 -- cylinder cover.

Fig 4. Rechmensky's Aero-centrifuge.

Fig 5. Dyakov's Apparatus: 1 -- air intake tubes; 2 -- outlet tube.

Fig.6. Rechmensky's Bacterial Collector: 1 -- terminal outlet; 2 -- spatula opening; 3 -- reservoir; 4 -- funnel.

Fig 7. Milyavsky's Apparatus: 1 -- Seitz funnel; 2 -- aspirating tube.

Fig 8. Rechmensky's Air-filter.

Fig 9. Bacteria Collector Mounted on Automobile.

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Footnote

* - Denotes names that are transliterated directly from the Russian text. (Translator's note).

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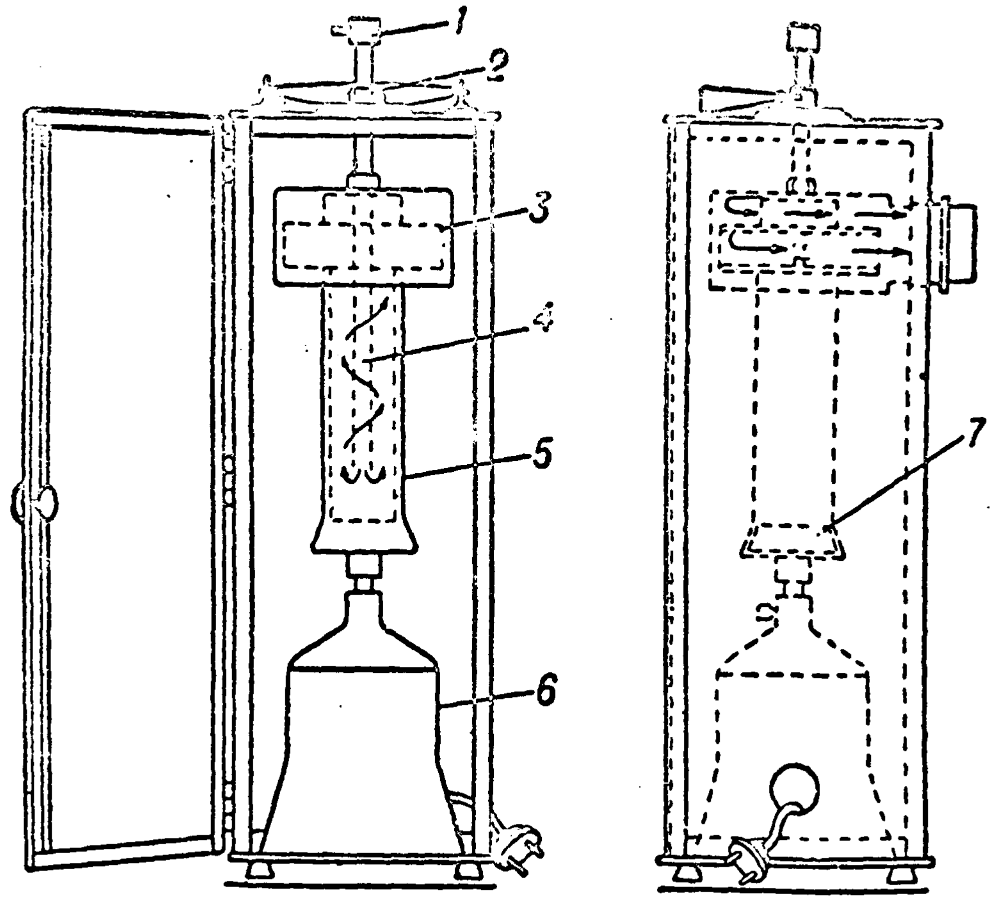

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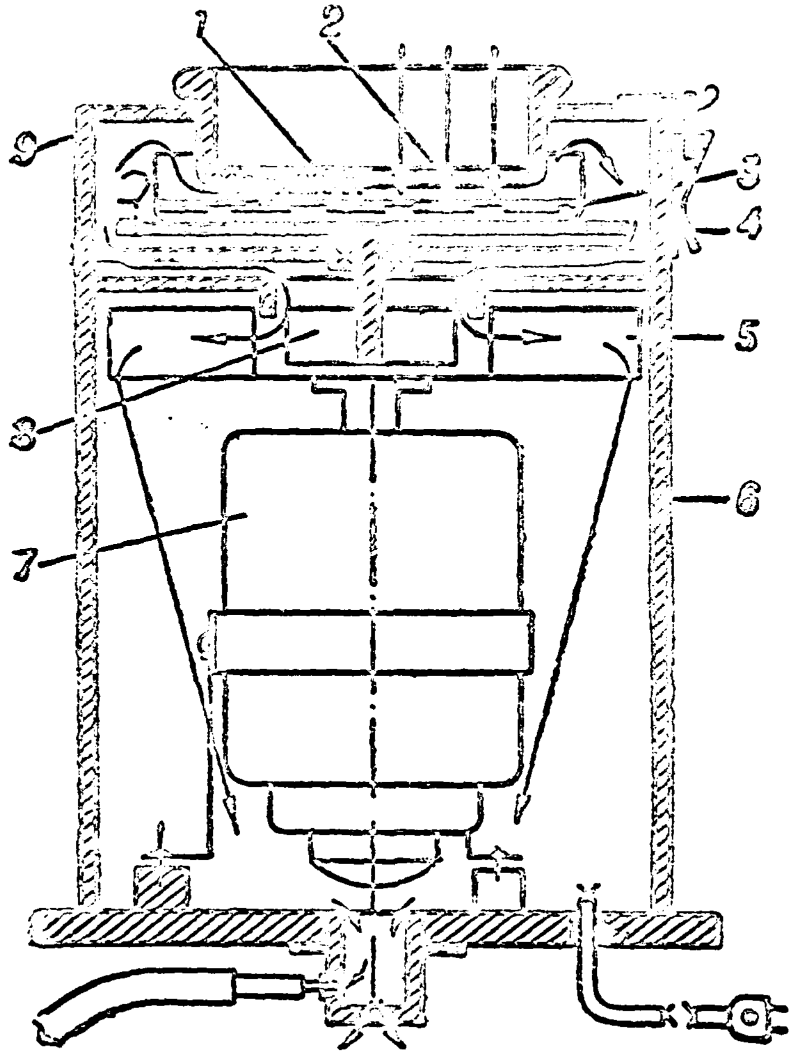

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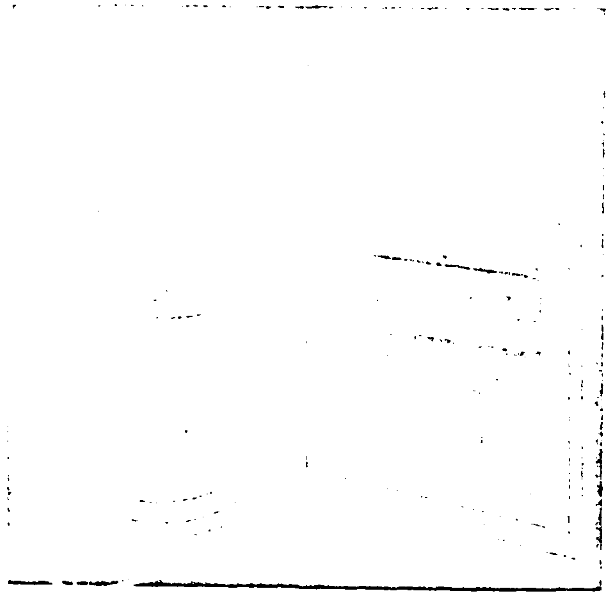

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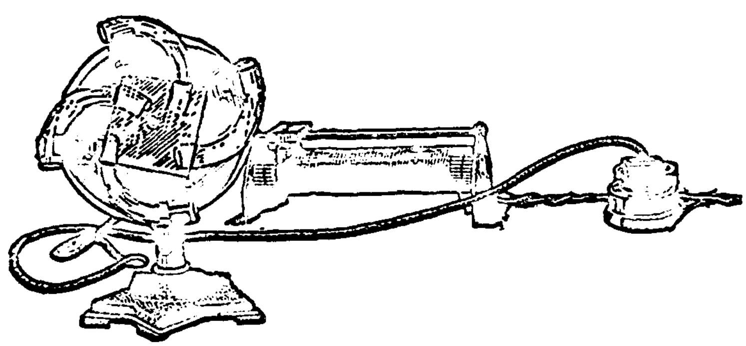

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Figure 4. Rechmensky's Aero-centrifuge.

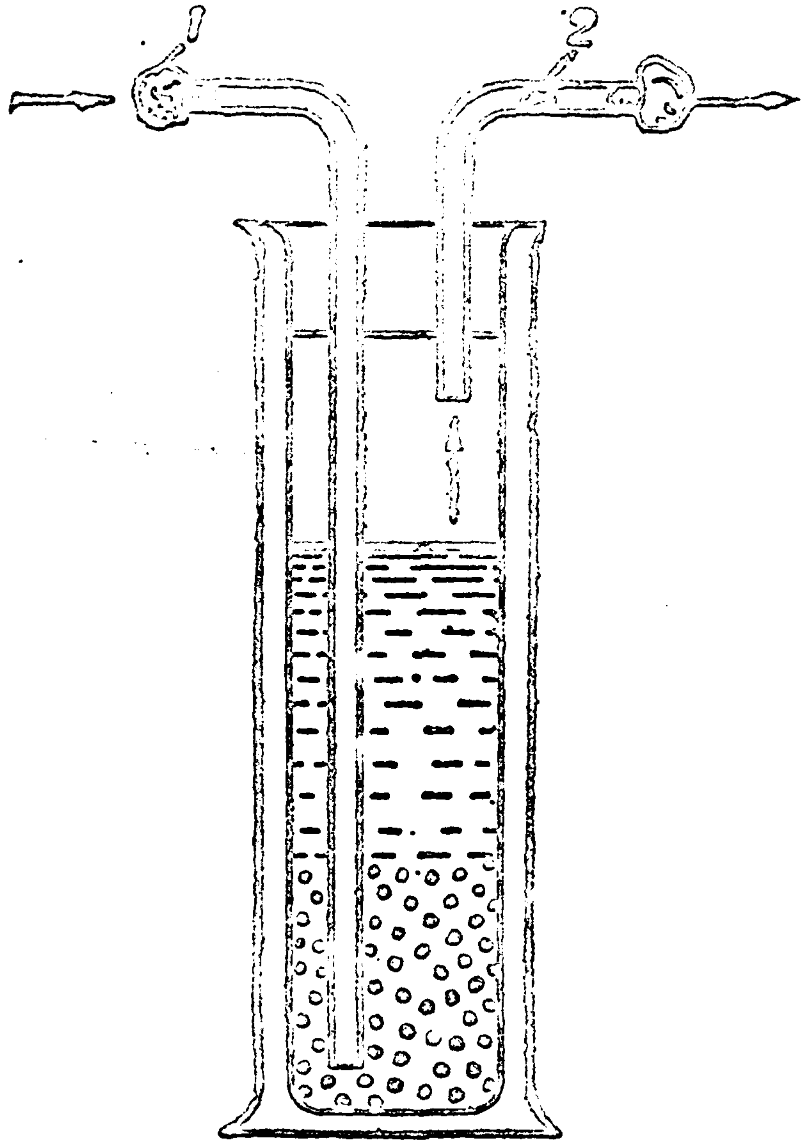


Figure 5. Dyakov's Apparatus: 1 -- air intake tube;
2 -- air outlet tube.

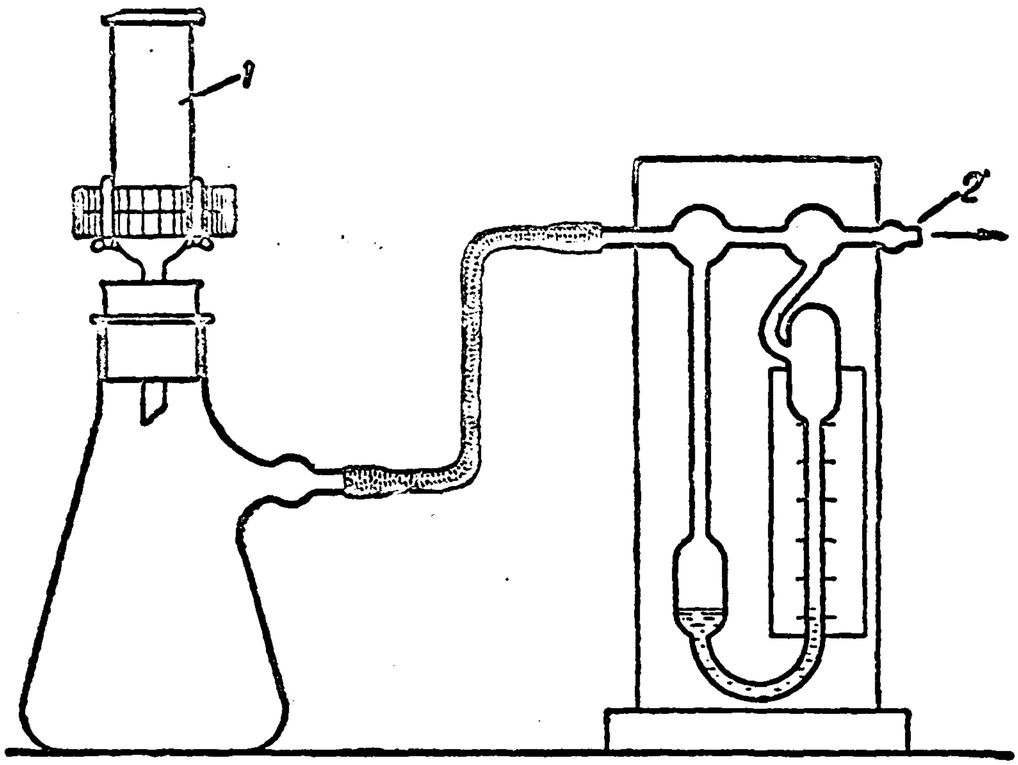


Figure 7. Milyavsky's Apparatus: 1 -- Seitz funnel; 2 -- aspirating tube.

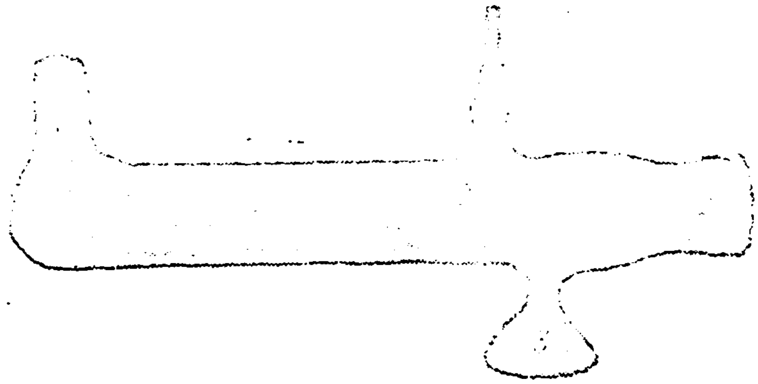
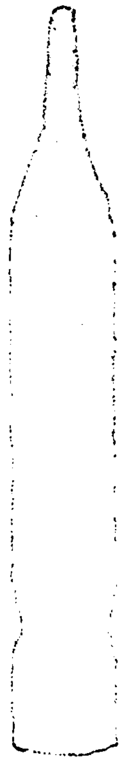


Figure 6. Rechmensky's Bacterial Collector: 1 -- terminal outlet; 2 -- spatula opening; 3 -- reservoir; 4 -- funnel.



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